

# Relationship among noise exposure, sensitivity, and noise annoyance with job satisfaction and job stress in a textile industry

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## Abstract

The purpose of this study was to investigate the relationship among noise exposure, sensitivity, and noise annoyance with job satisfaction and job stress among the workers of a textile industry. In this study, Weinstein's Noise Sensitivity Scale, Noise Annoyance Questionnaire (recommended based on ISO 15666-2003), Health and Safety Executive (HSE) Job Stress Questionnaire, and Job Satisfaction Scale were used to determine the degree of noise sensitivity, noise annoyance, occupational stress, and job satisfaction, respectively. The results showed that there was a significant difference in the mean of job satisfaction, job stress, noise sensitivity, and noise annoyance between case and control groups. The results of multivariate analysis of covariance showed that noise exposure, noise sensitivity, and noise annoyance can justify 0.09, 0.19, and 0.06 of the variance of job stress, respectively. These variables also could justify 0.09, 0.12, and 0.05 of the variance of job satisfaction, respectively. Noise sensitivity had the greatest effect on increasing the occupational stress and job satisfaction.

## Keywords

Noise exposure, noise annoyance, noise sensitivity, job stress, job satisfaction

## Introduction

Noise is an unwanted sound which introduces health and safety risks to workers occupied in various workplaces. There is consistent evidence that exposure to noise produces a wide range of physiological and psychological long-term effects<sup>1</sup> on the human being such as hearing loss,<sup>2</sup> cardiovascular diseases,<sup>3,4</sup> decrease in job satisfaction and psychological well-being,<sup>5,6</sup> and difficulties in communication,<sup>7–10</sup> annoyance, and sleep disorder.<sup>11</sup> There is evidence that noise exposure may increase employees' error rates and occupational accident, and reduce productivity.<sup>12</sup> The noise effects are mediated by individual feature such as sensitivity and psychological variable like noise annoyance.<sup>13–15</sup> Noise sensitivity is the main factor that severely predicts noise annoyance, and it can mediate the effects of noise on psychological aspects of health.<sup>16</sup> Noise sensitive people are more vulnerable against noise because they consider sound as a more dangerous factor compared with others, and they have more intense emotional responses to sound and, consequently, greater difficulty habituating.<sup>17</sup> Annoyance, as an outcome of noise exposure, has a strong

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negative relationship with psychological health and well-being.<sup>18</sup> Job stress is defined as “the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker.”<sup>19</sup> Many occupational factors may cause work-related stress, but among these factors, exposure to high and low levels of noise has a particular importance.<sup>20</sup> Job stress is related to number of numerous health problems such as cancer, cardiovascular diseases, depression, anxiety, and decreased job satisfaction.<sup>21</sup> Job satisfaction is strongly influenced by noise exposure.<sup>22</sup> Based on the above-mentioned data, it is expected that noise can affect work-related stress and job satisfaction by mediating noise sensitivity and annoyance. Reduced work-related stress and job satisfaction decrease work performance and productivity. Regarding the importance of occupational stress and job satisfaction, identifying factors which negatively affect these indexes is an optimal action to reduce or eliminate effective factors. Therefore, in this study, the relationship among noise exposure, sensitivity, and noise annoyance with job satisfaction and job stress was studied.

## Methods

This case-control study was conducted to investigate the effect of noise exposure, sensitivity, and noise annoyance with job satisfaction and occupational stress on 77 (42.1%) textile workers as the control group and 106 (57.9%) as the case group. The criteria for determining the control and case groups were less noise exposure level and more permissible exposure limit for noise exposure (85 dB A-weighted for 8 hours), respectively. In this study, Weinstein's Noise Sensitivity Scale (WNSS), Noise Annoyance Questionnaire (recommended based on ISO 15666-2003), HSE Job Stress Questionnaire, and Job Satisfaction Scale were used to determine the degree of noise sensitivity, noise annoyance, occupational stress, and job satisfaction, respectively. These tools were distributed among workers, and volunteer participants returned the completed questionnaire. In this pilot study, people with a history of anti-depressant drug use, working condition, workers' health status, and non-working life were excluded.

### WNSS

This scale is used to determine the sensitivity of noise, which is one of the attitudinal factors in causing the disturbance caused by noise. It is a valid and reliable tool for measuring individual noise sensitivity.<sup>23,24</sup> The scale comprised 21 items presented on a six-point scale, ranging from (most often) “agree strongly” (0) to “disagree strongly” (5). The maximum total score is 105 and the higher score indicates a higher sensitivity to the noise. Based on the overall score, the subjects are divided into three groups: without sensitivity (scores less than 25

percentiles), moderate sensitivity (scores between 25 and 75 percentiles), and high sensitivity (scores more than 75 percentiles).

### Noise Annoyance Scale (recommended based on ISO 15666-2003)

This scale was distributed among participants to measuring perceived annoyance caused by workplace noise.<sup>25</sup> For this purpose, people were asked to mark their perceived annoyance induced from the noise of the workplace during the last 12 months on a 11-point scale, ranging from 0 (*no annoyance*) to 10 (*extremely annoyed*).

### Health & Safety Executive (HSE) management standards indicator tool

HSE Job Stress Questionnaire is a good tool and indicator for identifying job stressors.<sup>26</sup> The questionnaire consists of 35 questions of seven sub-scales: Demand, Control, Changes, Officials' Support, Colleagues' Support, Relationship, and Role. The scoring of this tool is based on a Likert-type scale ranging from 1 (*never*) to 5 (*always*), and its score ranges from 35 to 175. A higher score indicates a higher job stress. Validity and reliability of the Persian version of this questionnaire have been confirmed by Azadmarzabadi and Gholami (Cronbach's alpha coefficient=0.78).<sup>27</sup>

### Job Satisfaction Scale

To determine job satisfaction, a 11-point scale was used. To this purpose, individuals were asked to mark their subjective response to their job satisfaction from 0 to 10. Higher score indicates higher job satisfaction.<sup>28</sup> In this scale, numbers 0, 2, 4, 6, 8, and 10 were without satisfaction, low satisfaction, moderate satisfaction, high satisfaction, and extreme satisfaction, respectively.<sup>29</sup>

### Noise measurement procedure

To determine the noise exposure level at workplaces, the procedure mentioned in ISO 9612 was followed.<sup>25</sup> First, all work stations were determined for each person. Then, in all locations, the equivalent sound level in A-weighting network was measured for 15 min as a representative of the exposure level at that location (given that at any location, the oscillation was less than 5 dB, 15 minute-measurement was sufficient). Furthermore, according to the time of presence at each station, as well as the equivalent sound level at that station, 8-h equivalent continuous A-weighted sound pressure level (LAeq,8h) was calculated according to the formula in standard ISO 9612. In this study, noise exposure was measured using a calibrated sound-level meter of the TES-1358.

**Table 1.** Descriptive information of the understudy variables.

Descriptive information	N	Minimum	Maximum	M	SD
Age	183	28.00	63.00	39.7596	6.40
Experience		6.00	31.00	14.8087	5.85
Noise annoyance		1.00	10.00	6.7322	2.42
Noise exposure		58.90	100.00	85.8109	11.81
Noise sensitivity		34.00	100.00	70.3770	13.34
Role		5.00	25.00	21.3607	3.10
Relationship		4.00	20.00	15.5301	3.67
Officials' support		5.00	28.00	17.8470	4.39
Colleagues' support		4.00	20.00	14.6776	3.26
Control		6.00	28.00	16.7158	4.45
Demand		13.00	36.00	23.6940	4.90
Changes		3.00	15.00	10.3716	2.98
Total job stress		55.00	160.00	120.2514	16.05
Job satisfaction		1.00	10.00	6.10	1.9

### Statistical analysis

The data were analyzed using SPSS 20. To compare the mean of the studied variables in the case and control groups, independent t-test was applied. Also, to test for the significant differences of the mean of job stress and job satisfaction among classified variables, the paired t-test and one-way analysis of variance (ANOVA) were used with two and three categories, respectively.

Finally, regarding the results of the above-mentioned tests, the variables which have a significant relationship with dependent variables were entered in a model of multivariate analysis of covariance (MANCOVA). In MANCOVA, statistical differences of independent categorized variables with the various continuous dependent variables are evaluated, while the impacts of the number of variables (covariates) are controlled. In this model, the impact of covariates on the association between the dependent and the independent variables is removed.

### Results

In 2017, this descriptive-analytical study was carried out on 183 workers in a textile industry. In the study, 11.5% (n=21) of the participants were single and 88.5% (n=162) were married. Also, 20.2% (n=37) of participants were hired as administrative staff, 21.9% (n=40) as technical, 25.7% (n=47) as spinning workers, and 32.2% (n=59) as weaving workers. Also, 65% (n=119) had used hearing protection equipment and 35% (n=64) did not use that. Based on the noise exposure results, 42.1% (n=77) of subjects were in the control group and 57.9% (n=106) in the case group. Also, 73.8% (n=135) of the participants were able to see the sources of sound, and 26.2% (n=48) remaining subjects did not observe the sources of sound. Other descriptive information is shown in Table 1.

The results of the independent t-test indicated that there was a significant difference in the mean of job satisfaction, job stress, changes, demand, support, role, noise sensitivity, work experience, and visibility of noise source between case and control groups. However, there was no significant difference among age, relationship, support, control, hearing protective equipment, and marital status between case and control groups. Further details are given in Table 2.

One-way ANOVA was used to determine the difference between the mean of job satisfaction and occupational stress in job groups, noise annoyance, noise sensitivity, age, and work experience (Table 3). The results showed that there was a significant difference between the mean of occupational stress among the noise exposure groups, annoyance, sensitivity, age, type of occupation, and work experience. The mean of occupational stress was higher in the case group, high sensitive people, extremely annoyed people, people with a higher age group, and people with work experience less than 10 years. Other results are evident in Table 3. According to Table 3, there was a significant difference between the average job satisfaction among all classified variables other than marital status. There was more average job satisfaction among age groups more than 45 years, people with work experience more than 20 years, people with annoyance less than 6 years, control group, people without sensitivity to noise, people without hearing protective devices, participants who could not see sources of noise, and technical workers.

The next step was to check the simultaneous effects of independent variables such as noise exposure, noise sensitivity, and noise annoyance on job stress and job satisfaction; while the effect of other variables is justified, MANCOVA was used. In general, this model was able to justify 41% and 45% of variances of job stress and job satisfaction, respectively. According to the eta coefficients obtained from this test, it can be stated that noise exposure, noise sensitivity, and noise annoyance can justify 0.09%,

**Table 2.** Differences of quantitative understudy variables between case and control groups.

Variables		Control, n = 77	Case, n = 106	p value
		M ± SD	M ± SD	
Age		39.3 ± 6.7	40.1 ± 6.2	0.30
Experience		15.2 ± 6.2	14.5 ± 5.6	0.051
Noise annoyance		6.2 ± 2.6	7.1 ± 2.2	0.014 <sup>ab</sup>
Noise sensitivity		67.6 ± 11.6	72.3 ± 14.2	0.01 <sup>*</sup>
Role		20.7 ± 4.9	21.8 ± 3.2	0.001 <sup>ab</sup>
Relationship		15.1 ± 4.1	15.8 ± 3.4	0.35
Officials' support		16.7 ± 4.5	18.6 ± 4.1	0.83
Colleagues' support		13.5 ± 3.7	15.5 ± 2.6	0.004 <sup>ab</sup>
Control		15.4 ± 4.7	17.6 ± 4.5	0.34
Demand		22.9 ± 5.3	24.2 ± 4.5	0.05 <sup>ab</sup>
Changes		9.5 ± 3.2	10.0 ± 2.7	0.05 <sup>ab</sup>
Job stress		113.9 ± 18.8	124.6 ± 12.1	0.001 <sup>ab</sup>
Job satisfaction		6.7 ± 2.3	5.6 ± 1.4	0.001 <sup>ab</sup>
Visibility of the noise source	Yes	n = 37	n = 98	0.001 <sup>ab</sup>
	No	n = 38	n = 10	
Hearing protective devices	Yes	n = 49	n = 70	0.45 <sup>a</sup>
	No	n = 26	n = 38	
Marital status	Married	n = 8	n = 13	0.44 <sup>a</sup>
	Single	n = 67	n = 95	

<sup>a</sup>Chi-square test.<sup>b</sup>Independent t-test.<sup>\*</sup>Significant at the 0.05 level; <sup>ab</sup>significant at the 0.01 level.

0.19%, and 0.06% of changes in the variance of job stress, respectively. Accordingly, it can be admitted that among the above-mentioned variables, the noise sensitivity has the greatest effect on increasing the occupational stress. However, these variables justify changes in job satisfaction variance of 0.09%, 0.12%, and 0.05%, respectively, and the most effect was related to noise sensitivity. According to the coefficients of  $\eta_p^2$  in relation to the combined effect of independent variables on stress and job satisfaction, it is evident that the variables of job stress ( $\eta_p^2 = 0.21$ ) are affected more than job satisfaction ( $\eta_p^2 = 0.20$ ) (Table 4).

## Discussion

Existing evidence in this study showed that occupational noise exposure, noise annoyance, and noise sensitivity can increase job stress and decrease job satisfaction. Among these factors, noise sensitivity has the greatest impact on job stress and job satisfaction (based on  $\eta_p^2$  shown in Table 4). This result is consistent with the study of Nordin et al., which revealed that noise sensitivity is related to perceived stress.<sup>30</sup> Noise sensitivity is a personal feature that increases individual vulnerability against noise and is relatively affected by noise,<sup>31</sup> so it can be said that noise exposure can affect job stress and job satisfaction through noise sensitivity indirectly. Previous studies showed that noise sensitive people have a decreased threshold for psychological stress response;<sup>32, 33</sup> thus, they perceive noise greater and

this can lead to the psychological and physiological health problems such as stress. In the Stansfeld et al. study, noise sensitivity has been related to poorer health-related quality of life and depressive symptoms, which in turn are related to stress and satisfaction.<sup>15, 34</sup> It has been hypothesized that noise sensitivity can be an indicator for vulnerability to sounds; thus, sensitive individuals might be more susceptible to disease, anxiety and depression, neuroticism, and posttraumatic stress disorder while exposed to noise.<sup>35–38</sup> In a structural equation model, Fyhri and Klæboe<sup>39</sup> revealed that association between noise sensitivity and somatic sign was more potent than the association between noise annoyance and symptoms. Based on the above-mentioned results and this study, it can be confirmed that noise sensitivity has an important role for causing stress and dissatisfaction among people exposed to noise.

The results of this study indicated that noise have a positive significant effect on job stress and an inverse effect on job satisfaction. This result was observed in the previous studies.<sup>9, 20, 40</sup> Evans and Johnson stated that long-lasting exposure to low-level noise may also have adverse effects on workplace satisfaction and job stress.<sup>41</sup> Mursali et al. revealed that prevalence of job stress in high- and low-noise conditions was 55% and 24.5%, respectively. In our study, workers who work in high-noise sections experienced 10 mean scores of job stress compared with workers in quieter sections. It seems that effect of noise on job stress is greater in the Mursali et al. study, which may be

**Table 3.** Comparison of the mean of job stress and job satisfaction by the categorized variables.

	Group	n	Job stress	p value	Job satisfaction	p value
			M $\pm$ SD		M $\pm$ SD	
Age	>35	55	112.4 $\pm$ 15.0	0.001**a	6.9 $\pm$ 1.9	0.005**a
	35–45	83	123.1 $\pm$ 12.2		5.7 $\pm$ 1.6	
	<45	45	124.6 $\pm$ 19.9		5.7 $\pm$ 2.3	
Experience	>10	60	123 $\pm$ 15.3	0.004**a	5.8 $\pm$ 2	0.004**a
	10–20	80	121.9 $\pm$ 14.5		5.8 $\pm$ 1.8	
	<20	43	113.3 $\pm$ 17.9		6.9 $\pm$ 2	
Noise annoyance	>6	83	113.9 $\pm$ 17.1	0.001**a	6.8 $\pm$ 2	0.001**a
	6–8	58	123.2 $\pm$ 11.9		5.7 $\pm$ 1.6	
	<8	42	128.6 $\pm$ 13.8		5.1 $\pm$ 1.5	
Noise exposure	Control	77	114.3 $\pm$ 17.7	0.001**	5.6 $\pm$ 1.56	0.001**b
	Case	106	124.5 $\pm$ 12.1		0.7 $\pm$ 2.3	
Noise sensitivity	>63 or (percentile 25)	49	116.0 $\pm$ 17.9	0.001**a	6.7 $\pm$ 2.0	0.001**a
	63–79 or (percentiles 25–75)	92	117.5 $\pm$ 14.4		6.2 $\pm$ 1.9	
	<79 or (percentile 75)	42	131.1 $\pm$ 12.1		5.0 $\pm$ 1.6	
Visibility of the noise source	Yes	135	125.8 $\pm$ 12.1	0.36	4.9 $\pm$ 1.4	0.003**b
	No	48	104.5 $\pm$ 15.4		7.8 $\pm$ 2.1	
Hearing protective devices	Yes	64	132.4 $\pm$ 14.1	0.43	4.9 $\pm$ 1.5	0.01**b
	No	119	113.7 $\pm$ 12.9		6.7 $\pm$ 1.8	
Type of job	Official staff	37	117.2 $\pm$ 20.3	0.001**a	6.2 $\pm$ 2.2	0.001**a
	Technician	40	112.3 $\pm$ 17.6		7.0 $\pm$ 2.4	
	Spinning staff	47	125.8 $\pm$ 12.3		5.4 $\pm$ 5.4	
	Weaver staff	59	123.1 $\pm$ 11.8		5.8 $\pm$ 5.8	
Marital status	Single	21	124.3 $\pm$ 14.7	0.84	5.6 $\pm$ 1.6	0.29
	Married	162	119.7 $\pm$ 16.1		6.0 $\pm$ 2	

<sup>a</sup>One-way analysis of variance.

<sup>b</sup>Independent t-test.

\*Significant at the 0.05 level; \*\*significant at the 0.01 level.

**Table 4.** Tests of between-subject effects to assess the effect of independent variables on dependent variables.

Source	Dependent variable	Type III sum of squares	df	Mean square	F	p value	$\eta_p^2$
Corrected model	Job satisfaction	283.3 <sup>a</sup>	25	11.3	4.4	0.001*	0.41
	Job stress	21,065.1 <sup>b</sup>	25	842.6	5.1	0.001*	0.45
Intercept	Job satisfaction	3202.4	1	3202.4	1240.7	0.001*	0.89
	Job stress	1,396,128.1	1	1,396,128.1	8517.2	0.001*	0.98
Noise sensitivity	Job satisfaction	56.3	2	28.1	10.9	0.001*	0.12
	Job stress	6186.1	2	3093.1	18.9	0.001*	0.19
Noise exposure	Job satisfaction	39.9	2	19.9	7.7	0.001*	0.09
	Job stress	2597.1	2	1298.5	7.9	0.001*	0.09
Noise annoyance	Job satisfaction	21.0	2	10.9	4.2	0.016*	0.05
	Job stress	1830.8	2	915.4	5.6	0.005*	0.06
Annoyance $\times$ sensitivity $\times$ noise exposure	Job satisfaction	102.5	19	5.4	2.1	0.007*	0.20
	Job stress	6753.1	19	355.4	2.2	0.005*	0.21
Error	Job satisfaction	405.2	157	2.6			
	Job stress	25,735.3	157	163.9			
Total	Job satisfaction	7385.0	183				
	Job stress	2,693,052.0	183				
Corrected total	Job satisfaction	688.5	182				
	Job stress	46,800.4	182				

df: degrees of freedom.

<sup>a</sup>R<sup>2</sup> = 0.411 (Adjusted R<sup>2</sup> = 0.318).

<sup>b</sup>R<sup>2</sup> = 0.450 (Adjusted R<sup>2</sup> = 0.363).

\*Significant at the 0.05 level.

due to differences in understudy population and research design.

The results of Pyoung et al. which obtained from office staff showed that there is no significant relationship between noise exposure and job satisfaction, but in this study, it is obvious that workers with high exposure to the noise had lower job satisfaction compared with workers with low exposure level. This may be due to differences in perceived workload in different conditions because a physical hardwork can affect job satisfaction in textile workers. In the another study by Sundstorm et al.,<sup>42</sup> it was clear that noise exposure had an inverse relationship with job satisfaction. Kim et al.<sup>43</sup> showed that among various factors affecting job satisfaction, workplace noise had third rank. In the Kim et al. study, low-noise level decreased job satisfaction, so it is expected that high level of noise exposure in textile workers can disturb job satisfaction. In the studies by Melamed et al.<sup>44</sup> and Raffaello and Maass,<sup>7</sup> the results indicated that high-level noise exposure can adversely influence job satisfaction in occupational workers. There is no precise mechanism for interaction between noise exposure and job satisfaction. It may be due to psychophysiological effects of noise such as noise annoyance. Overly, workers who work in a noisy workplace with high level of noise exposure are identified as stressed and dissatisfied due to social isolation which resulted from communication problems with their coworkers.

The results of this study indicated that noise annoyance has a positive significant effect on job stress and an inverse effect on job satisfaction. Yoon et al.<sup>45</sup> studied occupational noise annoyance relationship with depressive symptoms and suicidal ideation. They concluded that occupational noise annoyance can adversely impact psychological symptoms and mental health.<sup>45,46</sup> The direction of causality is not determined; however, it is clear that workers who have mental problem can perceive more annoyance compared with healthy workers, as well as noise annoyance can intensify the psychological problem. Fields et al.<sup>47</sup> stated that the noise level and individual perception of sound level are key elements that can impact human health. Noise annoyance is related to personal perception of noise exposure and, according to Fields et al., can affect stress and satisfaction that are part of human mental health.

According to the combined effect of independent variables on stress and job satisfaction, it is clear that job stress is affected more than job satisfaction. This shows that job stress is more vulnerable to noise exposure and its personal perception and subjective effects. There are a number of limitations in this study worth mentioning, and it is suggested that they will be considered in future studies. First, this study is confined to only one sitting; thus, caution should be taken when interpreting and generalizing the findings to other contexts. Second, in addition to the studied variables, job stress and job satisfaction are also affected by other variables such as working conditions,

workers' health status, and non-working life, which are beyond the scope of this study. Third, the interaction between job stress and job satisfaction is ignored.

Results of this study support the idea that occupational noise exposure annoyance and sensitivity can adversely affect job stress and job satisfaction of workers. These factors have a multidimensional interaction with occupational stress and satisfaction of workers.


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